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APPRENTICESHIP TRAINING

MACHINIST Program

Alberta
MANPOWER
Apprenticeship and
Trade Certification Division

55-95182

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MACHINIST TRADE

THE GOAL OF APPRENTICESHIP TRAINING

To develop a competent tradesman who, through skill and knowledge, is capable of producing with accuracy and precision any of the multitude of machine parts used in industry.

THE PRODUCT OF APPRENTICESHIP — a graduate who will:

★ have a thorough knowledge and understanding of the hand tools and power operated machines used for the shaping of metal into usable parts.

★ be skillfull in the safe use of these tools in order to produce machine parts according to specifications.

★ be capable of reading and laying out projects from drawings.

★ be skillful in using measuring devices in order to reproduce parts when no drawing exists.

★ know the characteristics of various metals.

★ understand the effects of heat treatment on metals and be skillful in the performance of the various heat treatment processes.

★ be familiar with the work of other tradesmen doing related jobs, such as mechanics, millwrights and welders.

★ produce work economically and meet the requirements of a competitive industry.

MACHINIST
APPRENTICESHIP INFORMATION

Basic Requirements:

★ Indenture for four periods of Trade experience.

★ Attend an eight week technical training course in the first, second, third and fourth periods.

★ Fulfill the requirements for each period including a minimum number of hours or work experience, successfully complete the training course and obtain a satisfactory employer's report.

★ Education — a minimum acceptable education is a Grade 9 pass or equivalent as established by the Apprenticeship and Trade Certification office entrance examination.

★ Age — the minimum age for apprentices is 16 years. There is no upper age limit.

Credits:

★ Accelerated patterns of apprenticeship may be granted for related technical training and/or experience.

Benefits:

★ Apprenticeship is a learning-while-earning program. During the apprenticeship period, while working at the trade, apprentices are assured by regulation of a minimum percentage of the prevailing journeyman rate: 55% during the first period, 65% during the second period, 75% during the third period and 85% during the fourth period. Progress from one rate to the next takes place only after successful completion of all the requirements for each period. (Details are outlined in the Record Book.)

★ All apprentices 17 years of age and older are normally eligible for training allowances while attending technical training courses. These allowances are funded by the Canada Employment and Immigration Commission.

★ Administrative procedures establishing the amount of training allowance is complex and can vary with an individual's circumstances. Contact a local Canada Employment Centre for details.

★ An apprentice who successfully completes the program will graduate with an Alberta Completion of Apprenticeship Certificate and a Certificate of Qualification. It is also possible for the graduate to obtain an Interprovincial Red Seal by passing an additional examination and so become recognized as a qualified tradesman throughout Canada.

★ The most significant benefit to the graduate apprentice is that he is well trained in technical and practical aspects of the trade and is able to make a worthwhile and productive contribution to society. Society in return, will provide an opportunity for livelihood.

DIRECTIONS FOR PROSPECTIVE APPRENTICES

★ Contact your nearest Apprenticeship and Trade Certification Division for detailed information and counselling (see list of offices on page 54).

★ Obtain an application form from the Apprenticeship and Trade Certification Division and neatly complete, in full, the information requested of the apprentice.

★ Persevere in the search for apprentice employment and upon obtaining employment, give the application to the employer. It should be completed and returned to an Apprenticeship and Trade Certification Division forthwith.

★ Any time credit, for previous experience in the Machinist trade, should be discussed with the employer and requested on the application form by the employer.

★ Attach to the apprentice application a copy (transcript) of the marks for your last year of school. Applicants who do not have their school transcripts or a grade 9 standing are required to write an entrance examination. If transcripts have been lost, contact Alberta Education for information on school transcripts.

★ Prepare to be called for an entrance examination following submission of your application. You will be advised of the date, time and location.

★ A contract of apprenticeship is entered into between the apprentice and the employer and should be signed within 90 days after the apprentice application has been approved. If contracts have not been issued within this time, contact the Apprenticeship and Trade Certification Division.

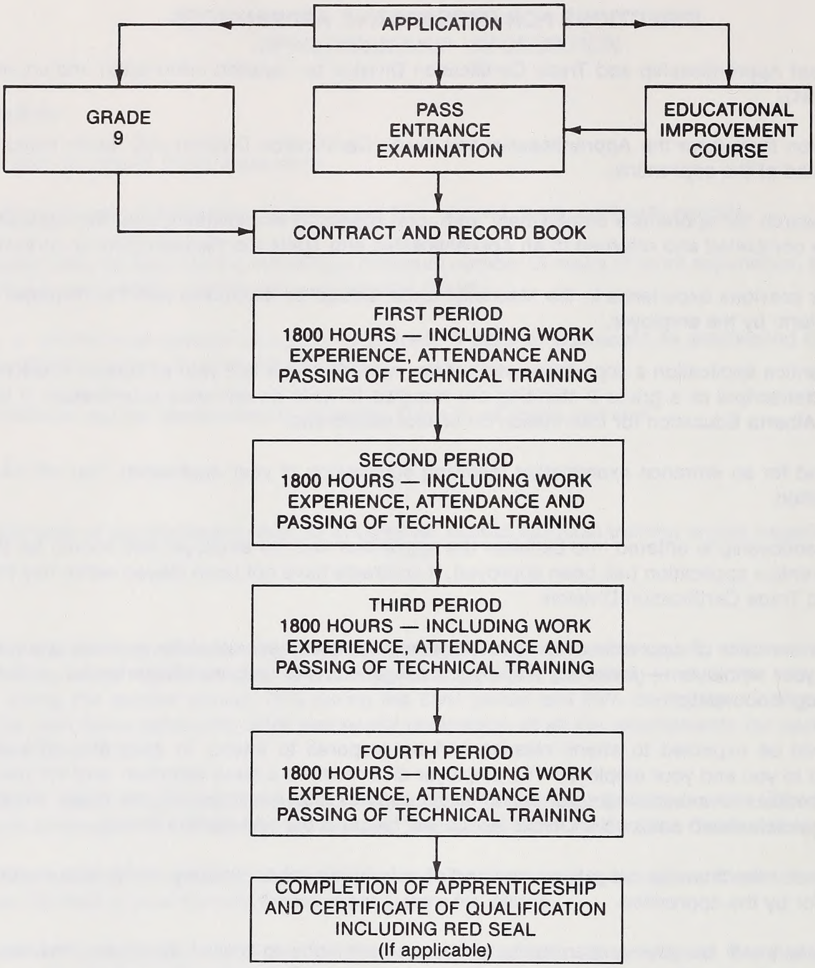
★ Before signing the contract of apprenticeship read the complete document carefully — know your obligations and responsibilities to your employer — know the employer's obligations and responsibilities to you — feel confident you have selected the right occupation.

★ Know when you will be expected to attend classes and be prepared to attend. In early May of each year, School Schedules are sent to you and your employer. The employer also receives a class selection card for you, which is to be completed and submitted for scheduling. Information on procedures also accompanies the above. Confirmation on the date you actually get scheduled and/or the Official Notice will follow at the appropriate time(s).

★ Prepare in advance for the financial obligations required of you during school training. Reference materials and school supplies are paid for by the apprentice.

★ While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from the Apprenticeship and Trade Certification Division.

APPRENTICESHIP ROUTE TOWARD CERTIFICATION


APPLICATION
GRADE 9
PASS ENTRANCE EXAMINATION
EDUCATIONAL IMPROVEMENT COURSE
CONTRACT AND RECORD BOOK
FIRST PERIOD
1800 HOURS — INCLUDING WORK EXPERIENCE, ATTENDANCE AND PASSING OF TECHNICAL TRAINING
SECOND PERIOD
1800 HOURS — INCLUDING WORK EXPERIENCE, ATTENDANCE AND PASSING OF TECHNICAL TRAINING
THIRD PERIOD
1800 HOURS — INCLUDING WORK EXPERIENCE, ATTENDANCE AND PASSING OF TECHNICAL TRAINING
FOURTH PERIOD
1800 HOURS — INCLUDING WORK EXPERIENCE, ATTENDANCE AND PASSING OF TECHNICAL TRAINING
COMPLETION OF APPRENTICESHIP AND CERTIFICATE OF QUALIFICATION INCLUDING RED SEAL
(If applicable)

APPRENTICESHIP COMMITTEE STRUCTURE

Machinist Provincial Apprenticeship Committee

The Provincial Apprenticeship Committee for the Machinist Trade is comprised of members from Local Apprenticeship Committees from the cities of Calgary and Edmonton.

This Committee is concerned with the policies that guide the program and make recommendations to the Apprenticeship and Trade Certification Board and the Executive Director of Apprenticeship and Trade Certification Division in the following areas:

- ★ Contribute current information relative to changes in the trade and requirements of industry.
- ★ Make recommendations for changes to existing trade regulations.
- ★ Assist in updating of the training program through recommendations for revisions to the course outline and attendant examinations.

Machinist Local Apprenticeship Committee

Local Apprenticeship Committees are concerned with individuals and trade situations within a local region. Meetings are held throughout the year to make recommendations and to discuss problems relating to the apprenticeship program. Members who serve on committees are nominated by employer and labour organizations, and membership is equally divided into employer and employee representation in accordance with The Manpower Development Act.

Apprenticeship Committee Members:

Mr. L. Stenger — Edmonton — Employee
Mr. W. Machura — Edmonton — Employee
Mr. A. Y. Campbell — Edmonton — Employer
Mr. W. J. Saumer — Edmonton — Employer
Mr. M. Mounteer — Edmonton — Employee (Alternate)
Mr. R. A. Corbett — Edmonton — Additional Member
Mr. F. N. Lhenen — Calgary — Employer
Mr. S. S. Ditchfield — Calgary — Employee
Mr. G. W. Wineberger — Calgary — Employer
Mr. T. Husak — Calgary — Employee
Mr. J. H. Hermans — Calgary — Employer (Alternate)
Mr. J. M. Van Der Roest — Calgary — Employee (Alternate)

PREFACE

The Ratio of Theory and Shop

In the interest of flexibility, the course outline for the Machinist trade, is shown in subject areas only for the purpose of depth instruction and does not necessarily reflect the rigid conformation of hours to each area.

Theory may become an accepted part of shop instruction, while other portions shall be taught as a classroom subject only.

Though the specific characteristics of certain items of subject material cannot be effectively covered by both shop and theory situations, the objective ratio should be directed towards a 50/50 proportion as far as feasible.

Mathematics — Blueprint Reading

The subjects of Mathematics and Blueprint Reading have been determined as being integral components of the technical training when they are applied in the strictest terms of trade involvement, specifically related to the trade.

Imperial (Inch) — SI (Metric)

The requirements of industry to meet the demand for SI products require the preparation of Machinist apprentices to include both Imperial and SI knowledge and skills. Technical training therefore should include theoretical and practical instruction to enable apprentices to perform adequately in both of these systems.

OCCUPATIONAL HEALTH AND SAFETY REGULATIONS

The relationship between these regulations and safety will be observed throughout the program.

MACHINIST PROGRAM
COURSE OUTLINE

This outline has been prepared in accordance with recommendations from the Provincial Apprenticeship Committee for the Machinist Trade in the Province of Alberta.

The outline was updated following consideration given to recommendations and suggestions from:

Local Apprenticeship Committees
Representatives from training institutes
Curriculum Sub-Committee from the Provincial Apprenticeship Committee

PROCEDURES FOR RECOMMENDING REVISION(S) TO THE COURSE OUTLINE

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to the Apprenticeship and Trade Certification Division, Edmonton.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

SAFETY EDUCATION

Safe working procedures and conditions, accident prevention and the preservation of health is of primary importance in the Apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of the government, employers, employees and the general public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm and that safe learning experiences and environment can be created by controlling the variables and behaviors that may contribute to or cause an accident and/or an injury.

It is generally recognized that a safe attitude contributes to an accident free environment. As a result a healthy safe attitude towards accident prevention will benefit an employee by helping to avoid injury, loss of time and loss of pay.

A tradesman is possibly exposed to more hazards than any other person in the work force and therefore, should be familiar with the Occupational Health and Safety Act and Regulations dealing with his own personal safety and the special safety rules applying to each job.

LEGAL AND ADMINISTRATIVE ASPECTS

Employer's Responsibilities:

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The company is responsible for:

1. The provision and maintenance of safety equipment
2. The provision of protective devices and clothing (as required by the Occupational Health & Safety Act, General Safety Regulations)
3. The enforcement of safe working procedures
4. Adequate safeguards for machinery, equipment and tools
5. Observance of all accident prevention regulations
6. Adequate training to allow a worker to use or operate equipment in an effective and safe manner.

Government's Responsibilities:

The Apprenticeship and Trade Certification Division in conjunction with the respective Provincial Apprenticeship Committee assumes the responsibility to assure that adequate safety is reflected in the curriculum and that adequate safety instruction is presented at the training establishments.

The Occupational Health and Safety Inspection Branch assumes the responsibility for periodic inspection of the operation to ensure that regulations for industry are being correctly observed.

Individual's Responsibilities:

The employee is responsible for:

1. Knowing and working in accordance with the safety regulations pertaining to job environment and
2. Working in such a way as not to endanger himself or his fellow employees

The major factor in safety is the individual employee, his personal attitude toward safety and having an awareness of the respective safety regulation.

MACHINIST PROGRAM

Subjects and Time Distribution

First Period:	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Theory and Metallurgy		64
Section Two:	Shopwork		112
Section Three:	Trade Mathematics		32
Section Four:	Blueprint Reading		32
Second Period:	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Theory		48
	Shopwork		112
Section Three:	Metallurgy and Heat Treatment		24
Section Four:	Trade Mathematics		24
Section Five:	Blueprint Reading		24
Section Six:	Machinery's Handbook		8
Third Period:	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Theory		72
	Shopwork		112
Section Three:	Trade Mathematics		24
Section Four:	Blueprint Reading		24
Section Five:	Machinery's Handbook		8
Fourth Period:	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Theory		80
	Shopwork		112
Section Three:	Trade Mathematics		16
Section Four:	Blueprint Reading		24
Section Five:	Machinery's Handbook		8

MACHINIST APPRENTICESHIP TRAINING PROGRAM

FIRST YEAR	SUGGESTED TIME DISTRIBUTION	SUGGESTED HOURS
SECTION ONE:	THEORY AND METALLURGY	64 HOURS
A. Introduction		2 Hours
B. Measurement		7 Hours
C. Layout		2 Hours
D. Benchwork		8 Hours
E. Threads		6 Hours
F. Fasteners		2 Hours
G. Tapers		3 Hours
H. Lubrication		1 Hour
I. Coolants		1 Hour
J. Offhand Grinders		2 Hours
K. Drilling Machines and Allied Work		8 Hours
L. Engine Lathe		15 Hours
M. Power Saws		2 Hours
N. Metallurgy		5 Hours
SECTION TWO:	SHOPWORK	112 Hours
SECTION THREE:	TRADE MATHEMATICS	32 Hours
A. Manipulation of Whole Numbers Fractions and Decimals		4 Hours
B. Measurement and Conversions		2 Hours
C. Formulae and Equations		5 Hours
D. Manipulation of Formulae and Equations		5 Hours
E. How to Read Tables, Graphs and Nomographs		3 Hours
F. Ratio and Proportion		3 Hours
G. Calculating Percent		4 Hours
H. Triangle Terminology and Special Triangles		6 Hours
SECTION FOUR:	BLUEPRINT READING	32 Hours
A. Introduction to Blueprint Reading		8 Hours
B. Isometric and Orthographic Views		6 Hours
C. Sectional Views		4 Hours
D. Commercial Shapes		2 Hours
E. Fasteners and Bearings		4 Hours
F. Applied Blueprint Reading		8 Hours

FIRST YEAR TECHNICAL TRAINING

SECTION ONE: **THEORY AND METALLURGY** **64 Hours**

TOPIC	COURSE OBJECTIVES
A. Introduction	
1. Program orientation (a) attendance and deportment (b) Apprenticeship and Trade Certification Division (c) reference books, study methods	
B. Measurement — Imperial (Inch) and SI (Metric)	
1. Limits and fits (introduction) 2. Effects of temperature change 3. Micrometers (all types) 4. Calipers (all types) 5. Vernier instruments 6. Telescope gauges 7. Ball gauges 8. Drill size gauges 9. Radius gauges 10. Dial gauges 11. Thickness gauges 12. Hole and bore gauges 13. Fixed gauges 14. Surface finish indicators 15. Squares 16. Protractors 17. Adjustable parallels	a. Identify and describe the various precision measuring tools used in the machine shop. b. Identify and describe the use of precision measuring tools used in the machine shop. c. Describe proper care, maintenance and storage of measuring tools used.
C. Layout	
1. Surface plates 2. Laying out the work piece from drawings and specifications 3. Coatings used for layout preparation 4. Scribers 5. Prick punches 6. Centre punches 7. Hammers 8. Trammels 9. Dividers 10. Hermaphrodite calipers 11. Surface gauges 12. Vernier height gauges 13. Clamps (a) "C" (b) keyseat 14. Templates 15. Combination squares 16. Straight edges	a. Identify layout tools and equipment. b. Describe the use of layout tools and equipment. c. Describe proper care, maintenance and storage of layout tools and equipment.

TOPIC	COURSE OBJECTIVES
17. Protractors 18. Angle plates 19. Parallels 20. "V" blocks 21. Sine bars 22. Gauge blocks (introduction)	
D. Benchwork 1. Vises 2. Hammers 3. Metal stamps 4. Screwdrivers 5. Wrenches 6. Hacksaws and blades 7. Files 8. Abrasive cloths 9. Cold chisels 10. Punches 11. Taps 12. Dies 13. Hand reamers 14. Stud extractors 15. Broken tool extractors 16. Scrapers 17. Pliers 18. Hand broaches 19. Lapping plates and abrasives 20. Thread reconditioning by inserts 21. Safety (a) general (b) regulations	a. Identify and describe bench tools and equipment. b. Describe the safe use of bench tools and equipment. c. Describe the proper care, maintenance and storage of bench tools and equipment. d. Describe safety rules and precautions pertaining to bench work including good housekeeping practices.
E. Threads — Imperial and SI 1. Parts 2. Terminology and designation 3. Fits and classifications 4. Measuring and gauging 5. Forms 6. Calculations 7. Uses 8. Applications 9. Thread series (a) UNC, NC (b) UNF, NF (c) UNEF, UNS, NS (d) UN series (e) NPT (f) metric series	a. Identify and describe types of thread form and purpose of their use. b. Identify and describe thread classes, terms and symbols. c. Perform necessary calculations. d. Describe methods used to accurately measure and gauge threads.
F. Fasteners — Imperial and SI 1. Threaded 2. Non threaded	a. Identify and describe types of fasteners and their applications. b. Identify and describe common types of keys and their applications.

TOPIC	COURSE OBJECTIVES
3. Head styles	
4. Point styles	
5. Driving recesses	
6. Tensile and grade definitions	
7. Common types of keys	
G. Tapers	
1. Parts	a. Identify and describe types of tapers and their applications.
2. Purposes	b. Describe methods of taper measuring and gauging.
3. Measuring and gauging	c. Describe methods of manufacturing tapers, including necessary calculations.
4. Calculations	
5. Systems and applications	
6. Methods of producing	
H. Lubrication	
1. Purpose	a. Describe purpose of lubrication.
2. Types	b. Describe various types of lubrication and their applications.
3. Charts	c. List methods of applying lubricants.
4. Methods of application	d. Know the importance of lubrication scheduling.
5. Locations	
6. Scheduling	
I. Coolants	
1. Purpose	a. Identify and describe types of coolants available.
2. Types	b. Explain purpose of coolants.
3. Charts	c. Select correct coolants for the different materials and operations.
4. Methods of applications	d. Be aware of health hazards of some soluble coolants.
J. Offhand Grinders	
1. Pedestal	a. Describe types of grinders, their parts and functions.
2. Portable	b. Select proper grinding wheels and describe safe installation.
3. Construction	c. Describe proper dressing and truing of grinding wheels.
4. Limits and application	d. List safety rules and precautions pertaining to grinders.
5. Types of grinding wheels (a) silicone carbide (b) aluminum oxide (c) grain sizes	
6. Installing grinding wheels	
7. Dressing grinding wheels	
8. Truing grinding wheels	
9. Types of wire brushes and buffers	
10. Safety (a) general (b) regulations	
K. Drilling Machines and Allied Work — Imperial and SI	
1. Types of drilling machines (a) sensitive drill (b) pedestal drill (c) radial arm drill (d) turret drill (e) gang drill	a. Identify and describe the common types of drilling machines including their main parts and applications. b. Identify and describe types of drill press tools and their holding devices. c. Describe methods of sizing twist drills.

TOPIC

  - (f) N.C. drill
  - (g) in-line drill
  - (h) multispindle drill
2. Construction
3. Parts
4. Functions
5. Selection
6. Applications
7. Limitations
8. Tool holding devices
   - (a) chucks
   - (b) taper sleeves
   - (c) sockets
   - (d) tap holders
   - (e) attachments
   - (f) multispindle drill head
9. Types of drilling tools — Imperial and SI
   - (a) twist drills
   - (b) centre drills
   - (c) spade drills
   - (d) machine reamers
   - (e) counterbores
   - (f) countersinks
   - (g) spot facers
   - (h) hole saws
   - (i) machine taps
   - (j) gun hole drills
   - (k) oil hole drills
   - (l) selection and systems of sizing
   - (m) handling
   - (n) installation
   - (o) removal
   - (p) storage
10. Drill sharpening and modification
    - (a) offhand grinding
    - (b) drill grinding machines and attachments
    - (c) drill point geometry
    - (d) drill point modifications for various materials and operations
11. Types of work holding devices
    - (a) drill vises
    - (b) clamps, bolts and studs
    - (c) chucks
    - (d) drill jigs
    - (e) selection
    - (f) use
12. Operations performed on the drill press
    - (a) drilling
    - (b) reaming
    - (c) countersinking
    - (d) counterboring
    - (e) spot facing
    - (f) tapping
    - (g) hole sawing
    - (h) trepanning
    - (i) polishing

COURSE OBJECTIVES

d. Describe methods of sharpening drills, list reasons for drill point modification.

e. Identify and describe work holding methods.

f. Describe operations performed on drilling machines.

g. Perform speed and feed calculations and select same.

h. List types of drill material.

i. List safety rules and precautions pertaining to drilling machine operations.

j. Describe good housekeeping practices.

TOPIC

13. Speeds and feeds
    - (a) calculations
    - (b) selections
    - (c) applications
14. Safety
    - (a) general
    - (b) regulations

L. Engine Lathe (Imperial and SI)

1. Parts
    - (a) functions
    - (b) limitations
2. Construction
3. Types
4. Sizes
5. Function of controls
6. Work holding devices
    - (a) chucks
    - (b) collets
    - (c) mandrels
    - (d) face plates
    - (e) centres
    - (f) lathe dogs
    - (g) drive plates
    - (h) lathe fixtures
7. Tool holding devices
8. Cutting tools
    - (a) shapes
    - (b) sizes
    - (c) types
    - (d) grinding procedures
    - (e) usage
    - (f) material
9. Speeds and feeds
    - (a) calculations
    - (b) selections
    - (c) applications
10. Lathe accessories
    - (a) steady rests
    - (b) follower rests
    - (c) taper attachments
    - (d) grinding attachments
    - (e) milling attachments
    - (f) turret attachments
    - (g) stops
11. Lathe operations
    - (a) turning
        - (i) roughing
        - (ii) finishing
    - (b) facing
    - (c) grooving
    - (d) parting off
    - (e) boring and counterboring
    - (f) taper turning
    - (g) form and profile turning
    - (h) threading
        - (i) single point
        - (ii) taps and dies
        - (iii) centre and pitch gauges
    - (i) filing and deburring
    - (j) polishing
    - (k) drilling

COURSE OBJECTIVES

a. Identify types of engine lathes, their parts, controls and how lathes are sized.

b. Describe types of work holding devices.

c. Describe types of tool holding devices.

d. Describe types of cutting tools, their geometry, sizes and materials and proper tool grinding procedure.

e. Calculate and select proper speeds and feeds.

f. Describe common accessories.

g. Describe common operations performed.

h. List safety rules and precautions pertaining to engine lathe operations.

i. Describe good housekeeping practices.

TOPIC

COURSE OBJECTIVES

- (l) centre drilling
- (m) reaming
- (n) knurling
- (o) turning between centres

12. Safety
    - (a) general
    - (b) regulations

M. Power Saws

1. Types
    - (a) power hack saws
    - (b) circular cut off saws
    - (c) band saws
        - (i) vertical
        - (ii) horizontal
    - (d) abrasive cut off machines
2. Blades
    - (a) types
    - (b) uses
    - (c) welding
    - (d) selection
3. Speeds and feeds
4. Power feed attachments
5. Power saw operations
    - (a) stock cutting, including multiple cutting
    - (b) internal cutting on band saws
    - (c) external cutting on band saws
    - (d) friction sawing
    - (e) band filing
6. Safety
    - (a) general
    - (b) regulations

a. Describe the types of power saws and cut off machines.

b. Identify and describe the types of blades, bands and wheels used on power saws and cut off machines.

c. Select proper feeds and speeds and describe operations.

d. Describe proper saw blade and cut off wheel mounting and operation.

e. List and describe safety rules and precautions regarding power saw and cut off machine operations.

N. Metallurgy — Imperial and SI

1. Physical properties of metals
2. Manufacture of iron and steel
3. Materials
    - (a) carbon steels
    - (b) alloy steels
    - (c) nonferrous metals
    - (d) high temperature metals
    - (e) finishing processes
4. Steel classification and identification systems
    - (a) SAE system
    - (b) AISI system
    - (c) color codes
5. Heat treatment
    - (a) terminology
    - (b) tempering
    - (c) annealing
    - (d) normalizing
    - (e) hardening
6. Safety
    - (a) general
    - (b) regulations

a. Identify and describe the composition of iron, cast iron, ferrous, nonferrous metals and alloys.

b. Describe methods of manufacturing iron, cast iron, steel and alloys.

c. Describe types of cast iron and steel classifying systems.

d. Describe the common mechanical properties of metal.

e. Describe common heat treating processes and common quenching media.

f. Describe hardening and tempering using oxy-acetylene heating equipment.

g. Describe safety rules and precautions pertaining to heat treating operations.

SECTION TWO: SHOPWORK

Shopwork experience should relate items outlined in theory section to shop operations by producing selected shop projects. This experience should complement the theory instruction by providing opportunities for efficient, productive and safe operation and/or demonstration of:

TOPIC	COURSE OBJECTIVES
A. Bench Tools and Equipment	
B. Hand Broaching Equipment	
C. Hand Lapping Equipment	
D. Offhand Grinders	
E. Drill Presses	
F. Engine Lathes 1. Roughing 2. Finishing	
G. Power Saws	
H. Metallurgy, Heat Treatment	

SECTION THREE: TRADE MATHEMATICS

The mathematics content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC	COURSE OBJECTIVES
A. Manipulation of Whole Numbers, Fractions and Decimals	
1. The number line (a) whole numbers	a. Section A should provide the apprentice with the opportunity to review basic mathematical skills.
2. Fractions (a) common (b) proper (c) decimal (d) improper (e) lowest common denominator (f) lowest term of fraction	
3. Mixed numbers	
4. Basic calculations (a) adding (b) multiplying (c) subtracting (d) dividing (e) signs of operation	
5. Rounding off (a) principles (b) applications	
B. Measurements and Conversions	
1. Imperial System (inch)	a. Convert feet into inches, inches into feet.
2. Introduction of SI (metric) (a) terminology of the SI units for (i) linear (ii) area (iii) volume (iv) liquid (v) mass	b. Convert degrees into minutes, seconds and second, minutes into degrees. c. Convert into metric.

TOPIC | COURSE OBJECTIVES

- (b) flexibility of the SI units
- (c) conversion charts

3. Conversion factors
    - (a) inch to feet, etc.
    - (b) millimeters to metres, etc.
    - (c) SI to imperial and vice versa
    - (d) angular conversions
        - (i) degrees
        - (ii) minutes
        - (iii) seconds
        - (iv) decimal equivalent

C. Formulae and Equations — Imperial and SI

1. Threads
    - (a) pitch and lead
    - (b) tap drill size
    - (c) Depth of thread
        - (i) internal
        - (ii) external
    - (d) amount of infeed
    - (e) diameter of number screw threads
2. Tapers
    - (a) amount of taper
    - (b) taper per foot
    - (c) taper per inch
    - (d) taper ratio
    - (e) amount of taper gauge advance
    - (f) tail stock offset
3. Speeds and Feeds
    - (a) RPM for drilling and lathe work
    - (b) cutting speeds
    - (c) feed rates
4. Others
    - (a) circumference of circles
    - (b) area of circles
    - (c) simple indexing

a. Calculate information required from available formulas.

D. Manipulation of Formulae and Equations — Imperial and SI

1. The symmetry property
2. The addition property
3. The subtraction property
4. The division property
5. The multiplication property
6. The order of operation property

a. Transpose mathematical formulae and equations.

E. How To Read Tables, Graphs and Nomographs — Imperial and SI

1. Decimal equivalent tables
2. Conversion tables
3. Tap drill tables
4. Taper and angle tables
5. Tables of squares
6. Tables of cubes
7. Tables of square roots
8. Tables of cube roots
9. Area of circle tables

a. Read and interpet tables and graphs available to provide information to the machinist.

TOPIC	COURSE OBJECTIVES
10. Tables of morse and std. milling tapers	
11. Tables of number and letter drills	
12. Temperature range graphs for various heat treatment operations	
13. Machinability rating tables	
14. Cutting fluid tables for various materials and operations	
15. Tables of cutting tool geometry	
16. Charts for bandsaw selections and speeds	
F. Ratio and Proportion	
1. Terminology (a) ratio (b) proportion (c) extremes and means	a. Define and use ratio and proportion to calculate and solve shop problems.
2. Application of ratio and proportion (a) single pulleys and gear trains (b) compound pulley, spur and worm gear systems (i) speeds (ii) diameters (iii) teeth (c) proportions of alloy compositions	
G. Calculating Percent	
1. Expressing percent (a) decimal fractions (b) decimal numbers (c) fractions	a. Calculate percent from decimal fractions, decimal numbers, fractions ratio and proportion and vice versa.
2. Calculating percent (a) by ratio and proportion (b) by fractions and multiplication	
H. Triangle Terminology and Special Triangles	
1. Terminology of triangles (a) isosceles (b) right (c) equilateral (d) oblique	a. Identify common triangles and their parts. b. Identify and demonstrate usage of the theory of Pythagorus c. Demonstrate use of ratio and proportion using triangles to solve shop problems.
2. Parts of triangles (a) right angle (b) acute angle (c) obtuse angle (d) hypotenuse (e) base (f) altitude	
3. The Pythagorean theorem	
4. Special triangles (a) 30 — 60 — 90 (b) 45 — 45 — 90 (c) 3 — 4 — 5 (d) 5 — 12 — 13	
5. Shop applications using special triangles as similar triangles (a) thread calculations (b) taper and bevel calculations	

TOPIC	COURSE OBJECTIVES
(c) problems involving squares and hexagons (d) problems involving hole locations	

SECTION FOUR: BLUEPRINT READING

The Blueprint Reading content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC	COURSE OBJECTIVES
A. Introduction to Blueprint Reading — Imperial and SI	
1. Lines and their applications (a) visible and centre lines (b) dashed or hidden lines (c) dimension, extension and leader lines	a. Describe types of lines used on blueprints. b. Describe proper blueprint dimensioning including common terminology, notes and dual dimensioning. c. List information given on blueprints that enables accurate component machining.
2. Dimensioning Methods (a) arrowheads and dimensions inside extension lines (b) leader lines (c) arrowheads outside and dimensions inside extension lines (d) arrowheads and dimensions outside the extension lines. (e) arrowheads inside and dimension outside the extension lines	
3. Dimensioning tapers and angles (a) amount of taper (b) large or small diameter (c) length of taper	
4. Dimensioning holes, circles, chamfers, arcs, threads, countersinks, drills, bores, spotfacing and radii (a) methods and their applications (b) notes on blueprints (c) abbreviations on blueprints	
5. Dual dimension on blueprints	
B. Isometric and Orthographic Views — Imperial and SI	
1. Orthographic projection (a) 6 views and their relative positions (b) the "key" view (c) the three common views (d) sketching various views (e) uses of two view projection (f) first and third angle projections (g) I.S.O. projection symbols	a. Describe and sketch orthographic and isometric views. b. List I.S.O. projection symbols.
2. Estimating dimensions	
3. Isometric sketches	
4. Sketching and dimensioning orthographic projection views	
C. Sectional Views — Imperial and SI	
1. Purpose	a. Explain the purpose of sectional views.

TOPIC	COURSE OBJECTIVES
2. Sectioning (a) full (b) half (c) removed (d) revolved (e) partial (f) purpose and application	b. Identify cutting plane lines on blueprints. c. Identify material symbols, i.e. cast iron, steel, aluminum, etc. d. Sketch sectional views.
3. Cutting Plane and Symmetry	
4. Methods of Indicating Cutting Plane Lines	
5. Section Lines (a) general purpose and cast iron (b) steel, brass, bronze and aluminum	
6. Parts requiring no sectioning (a) pins, rivets, screws, etc.	
7. Conventional breaks (a) for round and rectangular objects (b) purpose of such breaks	
D. Commercial Shapes	
1. Steel and nonferrous metals (a) round (b) hex (c) octagon (d) square (e) rectangular (f) pipe (g) angle (h) I-beams (i) U-channel (j) H-beam (k) T-bar (l) Z-bar (m) square, rectangular channel	a. Identify and describe the various commercial shapes of steel and nonferrous metals.
E. Fasteners and Bearings — Imperial and SI	
1. Sketching screw threads (a) pictorial (b) schematic (c) simplified	a. Sketch external and internal threads and know terminology for the same. b. Identify information given in thread specifications.
2. Thread specifications (a) O.D. and number of threads (b) thread series (c) external or internal (d) class of fit (e) hand of thread	c. Identify and sketch common types of keys and bearings. d. Identify and sketch various types of fasteners including head styles and list their specifications.
3. Terminology (a) blind hole (b) tap drill sizes	
4. Fasteners (a) head and point sizes (b) fastener specifications (c) finished and semi-finished (d) types of threaded fasteners (e) styles of head recesses (f) types of nonthreaded fasteners	
5. Keys, keyways and keyseats (a) types and their specifications on blueprints	

TOPIC	COURSE OBJECTIVES
(b) sketching keyways and keyseats	
6. Bearings (a) plain and antifriction (b) how to sketch bearings (c) how to indicate bearing specifications on blueprints	
7. Other fasteners (a) washers, nuts, pins (b) springs, rivets	
F. Applied Blueprint Reading — Imperial and SI	
1. Limits, fits and tolerances (a) definitions (b) applications (c) symbols (d) accumulation of tolerances	a. Read blueprints including information relating to tolerances, limits and fits. b. Sketch components and correctly identify threads, bearings, fasteners and material.
2. Working drawings (sketches) (a) title block (b) notes and dimensioning (c) detail and assembly sketches	

MACHINIST APPRENTICESHIP TRAINING PROGRAM

SECOND YEAR	SUGGESTED TIME DISTRIBUTION	SUGGESTED HOURS
SECTION ONE:	THEORY	48 Hours
A. Milling Machines, Milling Operations and Cutters		20 Hours
B. Advanced Threading		6 Hours
C. Lathe Attachments and Accessories		4 Hours
D. Advanced Cutting Tools		8 Hours
E. Turret and Other Production Lathes		4 Hours
F. Shapers, Planers and Slotters		6 Hours
SECTION TWO:	SHOPWORK	112 Hours
SECTION THREE:	METALLURGY AND HEAT TREATMENT	24 Hours
A. Metallugy		4 Hours
B. Heat Treatment and Testing of Metals		14 Hours
C. Oxy-acetylene Equipment		6 Hours
SECTION FOUR:	TRADE MATHEMATICS	24 Hours
A. Review of First Year Mathematics		6 Hours
B. Shop Applications of First Year Mathematics		6 Hours
C. Applied Geometry		6 Hours
D. Mechanics of Simple Machines		4 Hours
E. Indexing		2 Hours
1. Plain		
2. Angular		
SECTION FIVE:	BLUEPRINT READING	24 Hours
A. Review of First Year Blueprint Reading		8 Hours
B. Other Blueprint Considerations		6 Hours
C. Practical Application of Blueprint Theory		10 Hours
SECTION SIX:	MACHINERY'S HANDBOOK	8 Hours
A. Machinery's Handbook (suggested examples)		8 Hours

SECOND YEAR TECHNICAL TRAINING

SECTION ONE: **THEORY**

TOPIC

A. Milling Machines, Milling Operations and Cutters — Imperial and SI

1. Types of milling machines
   - (a) column and knee
   - (b) planer mill
   - (c) manufacturers
2. Common parts and controls
3. Principles of milling
   - (a) up and down milling
     - (i) advantages
     - (ii) limitations
4. Milling cutters
   - (a) types
     - (i) arbor
     - (ii) shank
     - (iii) flycutters
     - (iv) fluted
     - (v) form relieved
   - (b) cutter material
   - (c) selection of proper cutters
   - (d) storage of cutters
   - (e) sizing of cutters
5. Workholding devices
   - (a) vises
   - (b) fixtures
   - (c) dividing heads
   - (d) clamping tools and accessories
   - (e) rotary tables
6. Toolholding devices
   - (a) arbors
   - (b) collets
   - (c) adaptors
7. Milling machine speeds and feeds
   - (a) calculations
   - (b) selection
8. Milling machine operations and set-ups
   - (a) plain milling
   - (b) face milling
   - (c) slitting
   - (d) slotting
   - (e) straddle milling
   - (f) gang milling
   - (g) end milling
   - (h) form milling
   - (i) boring
   - (j) graduating
   - (k) flycutting
9. Milling machine attachments
   - (a) vertical milling head
   - (b) universal milling head
   - (c) rack milling attachment
   - (d) slotting attachment
   - (e) high speed milling attachment
   - (f) sine chucks
   - (g) tilting tables
   - (h) dividing head

COURSE OBJECTIVES

a. Identify and describe the types of milling machines, their parts, controls and control functions.

b. Describe types of milling cutters, tool holding and work holding devices and their uses.

c. Calculate and select proper cutting speed and feed rates including metric requirements.

d. Describe various milling machine attachments and accessories.

e. Calculate and select required indexing.

f. Describe maintenance and lubrication requirements.

g. List safety rules and regulations pertaining to milling machines.

TOPIC | COURSE OBJECTIVES

10. Dividing head indexing
    (a) direct
    (b) simple or plain
    (c) differential
    (d) angular
    (e) wide range dividing head
11. Safety
    (a) general
    (b) regulations

B. Advanced Threading — Imperial and SI

1. Review of unified, national and metric "V" thread theory
2. Manufacture of threads
    (a) production taps
    (b) production dies
    (c) single point tools
3. Forms and types of threads
    (a) acme
    (b) square
    (c) buttress
    (d) API
4. Applications and uses of threads
    (a) "V" threads
    (b) translational threads
5. Gauging and measuring threads
    (a) wire methods
    (b) thread limit gauges
    (c) thread comparators
6. Calculations
    (a) depth
    (b) pitch
    (c) tap drill sizes
    (d) pitch diameter
    (e) minor diameter
    (f) clearances for mating threads
7. Safety
    (a) general
    (b) regulations

a. Identify and describe screw thread parts, terms and designation terms.
b. Describe common thread forms and screw thread manufacturing methods.
c. Describe screw thread measuring and gauging devices.
d. Perform necessary calculations.

C. Lathe Attachments and Accessories

1. Attachments for engine lathes
    (a) taper
    (b) milling
    (c) grinding
    (d) turret
    (e) capstan
    (f) hydraulic tracing
    (g) rapid threading
2. Accessories for engine lathes
    (a) steady rests
    (b) follow rests
    (c) face plates
    (d) use of toolmakers buttons
    (e) catheads (spider) bushings
    (f) stops
    (g) boring table
    (h) spring winding
3. Safety
    (a) general
    (b) regulations

a. Identify and describe engine lathe attachments and accessories and explain their uses.
b. List safety procedures related to engine lathe accessories.

TOPIC

D. Advanced Cutting Tools, Imperial and SI

1. Tool materials
    - (a) carbides
    - (b) oxides
    - (c) cast alloys
    - (d) ceramics
    - (e) diamond
    - (f) H.S. steel developments
2. Standard designations (ANSI & SI)
    - (a) inserts — turning and milling
    - (b) turning tool holders
    - (c) milling cutters
    - (d) cartridges
    - (e) API tool holders
    - (f) qualified tool holders
3. Carbide applications
    - (a) turning tools and holders
        - (i) qualified
        - (ii) external
        - (iii) profiling
        - (iv) threading, grooving, forming and parting
        - (v) specific machining
        - (vi) internal
        - (vii) indexable inserts
    - (b) milling cutters and holders
        - (i) face mills
        - (ii) shoulder face mills
        - (iii) end mills
        - (iv) side and face milling cutters
        - (v) indexable inserts
        - (vi) mounting
        - (vii) accessories
        - (viii) special cutters and holders
    - (c) drilling tools, rotating and nonrotating holders
        - (i) brazed on
        - (ii) solid
        - (iii) insert
        - (iv) trepanning
    - (d) blanks and brazed tools
        - (i) blanks
        - (ii) solid rod
        - (iii) brazed single point tools
        - (iv) brazed tools for automatics
        - (v) grinding of carbide tools
4. Insert selection
    - (a) shape
    - (b) size
    - (c) thickness
    - (d) style
    - (e) nose radius
    - (f) tolerance
    - (g) chip groove geometry
    - (h) coated inserts
    - (i) grade
5. C.N.C. tooling considerations
6. Tool geometry
    - (a) rake angles
    - (b) lead angles
    - (c) clearance angles
    - (d) nose radius considerations

COURSE OBJECTIVES

a. Identify and describe cutting tool materials, their applications and methods of manufacture.

b. Describe carbide insert identification systems.

c. Calculate speed and feed requirements for different tool materials.

d. Describe cutting tool sharpening procedures.

e. Identify and describe purpose of cutting tool geometry.

f. List safety rules and precautions pertaining to cutting tools.

TOPIC

7. Elevated temperature machining
8. Operating conditions for carbide tools
    - (a) cutting speeds
    - (b) feeds
    - (c) depth in cut
    - (d) metal removal rates
    - (e) horsepower requirements
    - (f) determination of high efficiency cutting speed range
    - (g) angle of entry for milling cutters
9. Tool failure analysis
    - (a) normal flank wear
    - (b) cratering
    - (c) build-up edge
    - (d) chipping
    - (e) thermal cracking
    - (f) deformation
    - (g) notching
    - (h) fracture
10. Trouble shooting
    - (a) chatter and vibration
    - (b) cutting tool holder problems
    - (c) miscellaneous problems
11. Development and application of new tool materials and methods as they arise.
12. Safety
    - (a) general safety rules
    - (b) fragmented inserts
    - (c) chip control
    - (d) fire hazards
    - (e) health hazards
    - (f) work piece holding safety

E. Production Lathes — Imperial and SI

1. Types
    - (a) saddle turret
    - (b) hex turret
    - (c) capstan
    - (d) horizontal
    - (e) vertical
    - (f) automatic
    - (g) semi-automatic
2. Tooling
    - (a) balance turning tools
    - (b) multi-tool blocks
    - (c) knee tools
    - (d) roller and "V" steady tool
    - (e) boring tool holders
    - (f) drill holders
    - (g) reamer holders
    - (h) other tooling devices
3. Speed and feed calculations
4. Sequence and operation planning
    - (a) operation sheets
    - (b) tool set-up sketches
5. Safety
    - (a) general
    - (b) regulations

COURSE OBJECTIVES

a. Identify and describe turret and other production lathes.

b. Identify and describe tooling, set up and sequence operation procedures.

c. Calculate speed and feeds for production lathes.

d. List safety and maintenance precautions pertaining to production lathes.

TOPIC

COURSE OBJECTIVES

F. Shapers, Planers and Slotters — Imperial and SI

1. Types
   - (a) crank type shaper
   - (b) hydraulic shaper
   - (c) universal planer
   - (d) open side planer
   - (e) double housing planer
   - (f) slotters
2. Construction
   - (a) parts
   - (b) function
   - (c) movements
   - (d) operations
3. Cutting tools
   - (a) types
   - (b) material
4. Tool holders
   - (a) types
5. Work holding devices
   - (a) vises
   - (b) clamps
   - (c) fixtures
   - (d) chucks
   - (e) turntables
   - (f) indexing devices
6. Operations
   - (a) horizontal cutting
   - (b) vertical cutting
   - (c) angular surfaces
   - (d) internal keyways
   - (e) external keyways
   - (f) splines
   - (g) squares
   - (h) hexagons
   - (i) contour surfaces
7. Safety
   - (a) general
   - (b) regulations

a. Identify and describe the types, main parts, their applications, limitations and maintenance requirements of shapers, planers and slotters.

b. Describe cutting tools, tool holders and work holding devices utilized on shapers, planers and slotters.

c. Calculate shaper speeds and feeds.

d. List safety rules and precautions regarding shapers, planers and slotters.

SECTION TWO: SHOPWORK

Shopwork experience should relate items outlined in the theory section to shop operations by producing selected shop projects. This experience should complement the theory instruction by providing opportunities for efficient productive and safe operation and/or demonsration of

TOPIC

COURSE OBJECTIVES

A. Milling Machines

B. Engine Lathes

1. Roughing
2. Finishing

C. Lathe Attchments

D. Turret Lathe

E. Production Lathe

F. Shaper

TOPIC

COURSE OBJECTIVES

G. Heat Treatment

H. Spray Welding

SECTION THREE: METALLURGY AND HEAT TREATMENT

Theory instruction to be supplemented with practical work or demonstrations as necessary.

TOPIC

COURSE OBJECTIVES

A. Metallurgy

1. Review of first year metallurgy
   - (a) properties of metal
   - (b) manufacture of common metals
2. End use table for selecting various steel grades for specific application
3. Types of cast iron and their uses
   - (a) grey
   - (b) alloyed
   - (c) chilled
   - (d) white
   - (e) ductile
   - (f) malleable
4. Types of stainless steel and their uses
   - (a) austenitic
   - (b) martenistic
   - (c) ferritic
5. Powder metallurgy
   - (a) applications
   - (b) advantages
6. Spray welding
   - (a) wire and powder feed
   - (b) spray materials
   - (c) applications
   - (d) safety requirements

a. Group metals into ferrous and nonferrous categories.

b. Identify and describe common alloying elements and their mechanical properties.

c. Describe the manufacture of common metals.

d. Demonstrate table and handbook usage for selecting metals for different applications.

e. Describe applications of powder metallurgy.

f. Identify and describe types of spray welding including materials, applications and safety considerations.

B. Heat Treatment and Testing of Metals — Imperial and SI

1. Heat treatment of metals
   - (a) hardening
   - (b) tempering
   - (c) normalizing
   - (d) annealing
   - (e) quenching
   - (f) surface hardening
     - (i) carbon steel
     - (ii) alloy steel
2. Methods of heating metals
   - (a) oil furnace
   - (b) gas furnace
   - (c) electric furnace
   - (d) oxy-acetylene
   - (e) induction heating
3. Testing metals
   - (a) hardness
   - (b) toughness
   - (c) hardenability
   - (d) tensile strength
   - (e) surface cracks

a. Identify and describe hazards and safety precautions for heat treatment work areas.

b. Describe methods and processes utilized in heat treatment of metals.

c. Describe tests for hardness, toughness and tensile strength including nondestructive testing methods.

TOPIC | COURSE OBJECTIVES

4. Effects of hot and cold working of
    - (a) steels
    - (b) aluminum
    - (c) copper
5. Temperature control
    - (a) pyrometer
    - (b) tempel sticks
    - (c) color observation
6. Introduction to heat treatment of
    - (a) aluminum
    - (b) copper
7. Safety
    - (a) general
    - (b) regulations

C. Oxy-Acetylene Equipment

1. Cylinders
    - (a) types
    - (b) uses
    - (c) handling
    - (d) storage
2. Regulators
    - (a) types
    - (b) operation
    - (c) proper use
3. Hoses
    - (a) construction and size
    - (b) fittings and identification
    - (c) repairs and maintenance
4. Torch styles
    - (a) welding and cutting
    - (b) tips
    - (c) uses and restrictions
    - (d) repair and maintenance
5. Welding safety equipment and aids
    - (a) goggles — filter and safety lens
    - (b) tip cleaners
    - (c) flint igniter
    - (d) clothing
6. Setting-up equipment
    - (a) clearing cylinder valve
    - (b) securing cylinder
    - (c) attaching regulators and accessories
    - (d) setting pressures and flames
    - (e) shutting off procedures
7. Silver brazing
    - (a) material preparation
    - (b) types of silver brazing material
    - (c) types of flux
    - (d) types of flame
8. Flame Cutting
    - (a) types of metals that can be cut
    - (b) recognition of suitable flame
    - (c) operational procedures and precautions
9. Practical applications
    - (a) heating

a. Identify and describe hazardous conditions and safety precautions pertaining to oxy-acetylene equipment.

b. Describe types of cylinders, regulators hoses and torch styles and their applications.

c. Describe set-up procedures.

TOPIC — COURSE OBJECTIVES

    - (i) bending
    - (ii) shrink fits
    - (iii) heat treatment
  - (b) cutting
    - (i) nuts and bolts
    - (ii) removal of broken parts
    - (iii) other flame cutting operations as applicable
  - (c) silver brazing
    - (i) carbide tools
    - (ii) extension drills
    - (iii) other operations as applicable

10. Safety
    - (a) general
    - (b) regulations

SECTION FOUR: TRADE MATHEMATICS

The mathematics content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC — COURSE OBJECTIVES

A. Review of First Year Mathematics

1. Systems of measurement
2. Imperial — SI conversions
3. Manipulation of formulae and equations
4. Ratio and proportion

a. Section A should provide the apprentice with the opportunity to review first period mathematics.

B. Shop Applications of First Year Mathematics — Imperial and SI

1. Thread calculations for various forms
   - (a) pitch
   - (b) lead
   - (c) depth
   - (d) compound feed
   - (e) "V" forms
   - (f) square forms
   - (g) acme forms
2. Triangle calculations
   - (a) Pythagorean theorem
   - (b) similar triangle method
3. Taper calculations
4. Ratio and proportion
   - (a) percentage calculations
   - (b) taper calculations
   - (c) speeds of gear systems
   - (d) speeds of pulley systems
   - (e) oil line calculations
5. Tables, charts and graphs
   - (a) square roots
   - (b) squares
   - (c) cube roots
   - (d) cubes
   - (e) milling speed tables
   - (f) milling feed tables
   - (g) change gear tables for differential indexing
   - (h) change gear tables for helical milling

a. Section B should provide the apprentice with the practical application skills associated with first period mathematics.

TOPIC	COURSE OBJECTIVES
(i) tables of weights (masses) (j) charts used in heat treating of steels (k) others as applicable to the trade	
C. Applied Geometry	
1. Terminology used in applied geometry (a) parallelogram (b) frustrums (c) sector of a circle (d) segment of a circle (e) tangent line (f) quadrilateral (g) ellipse (h) trapezoids (i) cylinder (j) cone (k) pyramid (l) prisms (m) sphere (n) inscribed circle (o) circumscribed circle (p) polygon 2. Areas of triangle (a) right (b) isosceles (c) base altitude method (d) three side method 3. Circle calculations (a) segments (b) sectors (c) areas (d) circumference 4. Area of ellipse 5. Area of trapezoid 6. Volume and weight (mass) calculations (a) cylinders (b) cones (c) prisms (d) spheres 7. Area and volume calculations by similar — figure method	a. Describe common geometric forms. b. Calculate problems involving triangles, circles, trapezoids, ellipses. c. Calculate volume and weight of cylinder cones, prisms, spheres and frustrums of cones.
D. Mechanics of Simple Machines	
1. Simple machines (a) levers (b) pulleys (c) screws (d) inclined plane (e) wheel and axle (f) Pascal's Law 2. Terminology (a) mechanical advantage ratios (b) velocity ratios (c) efficiency (d) work (e) power (f) energy	a. Identify and describe common simple machines and applicable terminology. b. Calculate problems involving mechanical advantage. c. Calculate problems involving simple machines.

TOPIC	COURSE OBJECTIVES
3. Applications of simple machines (a) clamping work (b) lifting weights (mass) (c) screw jacks	
E. Indexing	
1. Plain	a. Calculate plain, angular and differential indexing.
2. Angular	
3. Differential	

SECTION FIVE: BLUEPRINT READING

The intent of the blueprint reading content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC	COURSE OBJECTIVES
A. Review of First Year Blueprint Reading — Imperial and SI	
1. Dimensioning (a) tapers and angles (b) holes and chamfers (c) threads	a. Section A should provide the apprentice with the opportunity to review first period Blueprint Reading.
2. Orthographic projections	
3. Isometric sketches	
4. Sectional views	
5. Accumulation of tolerances	
B. Other Blueprint Reading Considerations	
1. Surface finish symbols	a. Identify surface finish symbols and auxiliary planes.
2. Auxiliary planes	b. Identify standard welding symbols.
3. Welding specifications (a) American standard systems (b) types of joints (c) identification (d) indication	
C. Practical Application of Blueprint Theory — Imperial and SI	
1. Reading, interpreting and sketching complex machine parts and components (a) boring head (b) crane hook (c) head stock assembly of lathe (d) dividing head (e) tailstock and carriage assembly of lathe (f) gear drives (g) milling machine drive mechanism (h) tool joints (i) surface gauge project (j) others as applicable	a. Sketch complex machine parts including all information necessary to draw sketches of individual parts for manufacturing. b. Correctly read and understand blueprints.

SECTION SIX: MACHINERY'S HANDBOOK

TOPIC	COURSE OBJECTIVES
A. Machinery's Handbook (suggested examples)	
1. Tables of speed and fits — Imperial and SI	Instruction in the use of this book is intended to provide the Machinist apprentice with an opportunity to use the Machinery's Handbook to

TOPIC

- (a) drilling and reaming
- (b) turning
- (c) milling
- (d) shaping

2. Tables of weights, measure and conversions — Imperial and SI
    - (a) weights of materials
        - (i) various shapes
        - (ii) types of materials
3. Tables of keys — Imperial and SI
    - (a) dimensions
    - (b) various shapes
    - (c) key size to shaft diameter standards
4. Tables of fasteners — Imperial and SI
    - (a) bolts and screws
    - (b) nuts and washers
    - (c) pins and studs
    - (d) rivets
5. Tables of tapers
    - (a) morse
    - (b) steep and milling machine
    - (c) Brown and Sharpe
    - (d) Jarno
6. Tables of materials
    - (a) tensile strength
    - (b) classification of steel
        - (i) tool steel
        - (ii) machinery steel
        - (iii) stainless steel
    - (c) composition and properties
    - (d) heat treatment
    - (e) hardness scales
7. Tables of drilling tools — Imperial and SI
    - (a) standard drills and countersinks
    - (b) standard drill shank sizes
8. Tables of taps and dies — Imperial and SI
    - (a) symbol and thread designation
9. Tables and formulae of mathematics
    - (a) area and volume
    - (b) perimeters
    - (c) squares and hexagons
10. Tables of Imperial and SI threads
    - (a) depth
    - (b) tolerances and allowances
    - (c) standard series
    - (d) diameter and pitch combinations
    - (e) forms
    - (f) gauging wire sizes
        - (i) "V" thread
        - (ii) acme
11. Tables of milling cutters
    - (a) standard sizes
    - (b) types

COURSE OBJECTIVES

solve various trade related problems by augmenting theory with the use of tables, formulae, examples and other information.

a. Locate and utilize tables, graphs charts and other information pertinent to machine shop requirements.

TOPIC

COURSE OBJECTIVES

12. Tables of indexing
    - (a) compound
    - (b) simple and differential
    - (c) angular
    - (d) block or multiple
    - (e) rack
13. Tables of heat treatment
    - (a) tempering temperatures and colours
    - (b) temperature conversion (Imperial and SI)
    - (c) normalizing, annealing and hardening temperatures
        - (i) carbon steels
        - (ii) alloy steels

MACHINIST APPRENTICESHIP TRAINING PROGRAM

THIRD YEAR	SUGGESTED TIME DISTRIBUTION	SUGGESTED HOURS
SECTION ONE:	THEORY	72 Hours
A. Abrasive Products		8 Hours
B. Grinding Machines		7 Hours
C. Introduction to Gearing		10 Hours
D. Advanced Milling		5 Hours
E. Advanced Threading		4 Hours
F. Boring Mills		4 Hours
G. Machine Broaching		2 Hours
H. Theory of Jigs and Fixtures		8 Hours
I. Metrology		24 Hours
SECTION TWO:	SHOPWORK	112 Hours
SECTION THREE:	TRADE MATHEMATICS	24 Hours
A. Review of First and Second Year Material		6 Hours
B. Introduction to Trigonometry		6 Hours
C. Shop Applications of Trigonometry		12 Hours
SECTION FOUR:	BLUEPRINT READING	24 Hours
A. Review of First and Second Year Blueprint Reading		8 Hours
B. Blueprints of Castings		3 Hours
C. Arrowless (Co-ordinate) Dimensioning		3 Hours
D. Introduction to Machine Shop Estimating		10 Hours
SECTION FIVE:	MACHINERY'S HANDBOOK	8 Hours
A. Machinery's Handbook (Suggested Examples)		8 Hours

THIRD YEAR TECHNICAL TRAINING

SECTION ONE: THEORY

TOPIC — COURSE OBJECTIVES

A. Abrasive Products

1. Types
    - (a) manufactured
    - (b) natural
2. Grinding wheels
    - (a) manufacturing process
    - (b) types
    - (c) shapes
    - (d) identification
    - (e) dressing
    - (f) truing
    - (g) testing for cracks
    - (h) balancing
    - (i) applications
3. Mounted grinding wheels
    - (a) types
    - (b) identification
    - (c) uses
    - (d) mounting
    - (e) forming
4. Coated abrasives
    - (a) types of backing
    - (b) types of abrasives
    - (c) grades for hand operations
    - (d) grades for machine operations
5. Ultra finishing, precision processes
    - (a) honing machines
        - (i) procedures
        - (ii) types
        - (iii) applications
    - (b) lapping and super finishing
        - (i) abrasive compounds
    - (c) dressing sticks
        - (i) types
        - (ii) uses
6. Ultra finish, nonprecision processes
    - (a) machines
        - (i) procedures
        - (ii) application
    - (b) blasting
    - (c) buffing
    - (d) polishing
    - (e) barrel finishing (tumbling)
7. Safety
    - (a) general
    - (b) regulations

a. Identify and describe the types of natural and manufactured abrasives.

b. Identify and describe standard grinding wheel marking system, common wheel shapes and wheel manufacturing methods.

c. Describe grinding wheel selection, balancing, truing and dressing, including proper care and storage.

d. Describe coated abrasive products and their uses.

e. Describe precision and nonprecision finishes.

f. Identify and describe safety rules and precautions pertaining to grinding products.

B. Grinding Machines — Imperial and SI

1. Grinding processes
    - (a) general rules
    - (b) feeds
    - (c) speeds
    - (d) surface finishes
    - (e) depth of cuts

a. Identify and describe types of grinding machines, their parts, attachments and grinding operations.

b. Describe work holding methods and set-ups for grinders, including tool and cutter grinders.

c. Calculate speed, feed and depth of cut for grinding operations.

TOPIC

2. Work holding devices
    - (a) magnetic chucks
    - (b) vises
    - (c) "V" blocks
    - (d) clamps
    - (e) parallels
    - (f) fixtures
    - (g) chucks
    - (h) between centres
3. Grinding fluids
    - (a) types
    - (b) methods of application
4. Surface grinders
    - (a) types
    - (b) wheel arrangement
    - (c) table arrangement
    - (d) nomenclature
    - (e) controls
    - (f) operations
    - (g) set-ups
5. Cylindrical grinders
    - (a) types
    - (b) wheel arrangements
    - (c) table arrangement
    - (d) nomenclature
    - (e) control
    - (f) operation
    - (g) set-up
    - (h) plunge grinding
    - (i) traverse grinding
    - (j) shoulder grinding
    - (k) internal grinding
    - (l) taper grinding
    - (m) production grinding
    - (n) electrolytic grinding
6. Centreless grinders
    - (a) principles
    - (b) types
    - (c) nomenclature
    - (d) applications
    - (e) through feed
    - (f) in feed
    - (g) end feed
7. Other grinding machines and practices
    - (a) internal grinding
    - (b) crank shaft grinding
    - (c) piston grinding
    - (d) roll grinding
    - (e) cut off machines
    - (f) planetary grinders
    - (g) swing frame grinding
    - (h) crush grinding
8. Tool and cutter grinding
    - (a) operations to grind fluted and form relieved teeth
    - (b) cutter nomenclature
    - (c) special tooling
    - (d) special wheel shapes
    - (e) sharpening other tools
9. Safety
    - (a) general
    - (b) reguations

COURSE OBJECTIVES

d. Describe types of grinding fluids, their purpose and methods of application.

e. List safety rules and precautions pertaining to grinding machines.

TOPIC

C. Introduction to Gearing — Imperial and SI

1. Gear trains
   - (a) uses
   - (b) application
   - (c) types
2. Gears
   - (a) types
     - (i) spur
     - (ii) helical
     - (iii) bevel
     - (iv) worm
     - (v) hypoid
     - (vi) mitre
     - (vii) rack and pinion
     - (viii) herringbone
   - (b) calculations of spur gears and racks
   - (c) nomenclature
   - (d) types of teeth
   - (e) methods of manufacturing and finishing
     - (i) casting
     - (ii) involute and fly cutters
     - (iii) generation
     - (iv) shaping
     - (v) shaving
     - (vi) grinding
     - (vii) lapping
     - (viii) rolling
     - (ix) drawing
     - (x) extruding
     - (xi) stamping
     - (x) powder metallurgy
   - (f) materials used in manufacturing gears
   - (g) heat treatment of gears
3. Gear cutters
   - (a) types
     - (i) hob
     - (ii) involute
     - (iii) fly
   - (b) identification
   - (c) pressure angles
4. Gear tooth measurement
   - (a) tables
   - (b) methods
     - (i) vernier caliper
     - (ii) wire or pins
   - (c) backlash
5. Gear failure
   - (a) types
   - (b) prevention
6. Safety
   - (a) general
   - (b) regulations

COURSE OBJECTIVES

a. Identify types of gears, spur gear systems, gear drives and calculate gear drive speeds.

b. Describe, using common gear terminology gear and rack teeth parts.

c. Describe methods used to produce spur gears and materials used for gear manufacture.

d. Calculate information necessary to manufacture spur gears and racks and select proper milling cutters.

e. Describe the causes of and prevention of gear failure.

f. List safety precautions pertaining to gearing.

D. Advanced Milling — Imperial and SI

1. Review indexing methods
   - (a) calculating change gears (differential indexing)
2. Helical milling
   - (a) principles
   - (b) calculations

a. Describe helical milling processes on universal and vertical milling machines including methods used for short lead milling.

b. Use tables and perform calculations to find data required to helical mill, including indexing.

c. List safety precautions pertaining to helical milling.

TOPIC — COURSE OBJECTIVES

    - (i) helix angle
    - (ii) lead
    - (iii) change gears
  - (c) short lead
    - (i) methods
  - (d) methods of producing helical work
- 3. Safety
  - (a) general
  - (b) regulations

E. Advanced Threading — Imperial and SI

- 1. Review second year thread calculations
- 2. Production of multistart threads
  - (a) calculations
  - (b) procedure for cutting
  - (c) techniques
  - (d) set-ups
  - (e) indexing
  - (f) tool grinding
- 3. Worm and worm threads
  - (a) terminology
  - (b) applications
  - (c) calculations
  - (d) set-ups for cutting on
    - (i) lathe
    - (ii) milling machine
  - (e) materials best suited for the production of worm threads
  - (f) distinction between worm and acme threads
- 4. Methods of producing threads
  - (a) grinding
  - (b) milling
  - (c) rolling
- 5. Safety
  - (a) general
  - (b) regulations

- a. Identify and describe production methods used to produce threads, multi start threads, worm threads, including worm thread materials.
- b. Calculate numerical information required for thread and worm thread production.
- c. Identify and describe worm thread elements.
- d. List safety rules and precautions pertaining to thread production.

F. Boring Mills — Imperial and SI

- 1. Types
  - (a) horizontal
  - (b) vertical
- 2. Parts
- 3. Construction
- 4. Tooling
- 5. Accessories
- 6. Operations
- 7. Set-ups
- 8. Applications
- 9. Safety
  - (a) general
  - (b) regulations

- a. Identify and describe the types of boring mills, their parts, controls and functions including applications, work set-ups, tools and accessories.
- b. Calculate boring mill speeds and feeds.
- c. List safety rules and precautions pertaining to boring mills.

G. Machine Broaching — Imperial and SI

- 1. Types
- 2. Principles of operation
- 3. Tooling

- a. Describe the types of broaching machines and their applications.
- b. Describe broaching operations, cutting speed factors, set-ups and broach design considerations.

TOPIC

4. Preparation of work
5. Work holding devices
6. Speeds and feeds
7. Broach design consideration
8. Safety
    (a) general
    (b) regulations

COURSE OBJECTIVES

c. List safety rules and precautions pertaining to broaching machines.

H. Theory of Jigs and Fixtures — Imperial and SI

1. Types
2. Applications
    (a) conventional
    (b) C.N.C. applications
3. Principles of design
4. Locating work
    (a) methods
        (i) tooling for occasion
5. Clamping devices
    (a) methods
    (b) types
    (c) applications
6. Safety
    (a) general
    (b) regulations

a. Identify and describe the types of jigs and fixtures including their applications and design factors.

b. Describe locating methods and clamping devices used on jigs and fixtures.

c. List safety rules and precautions pertaining to jig and fixture usage.

I. Metrology — Imperial and SI

1. Systems of limits and fits
    (a) limits of size
    (b) tolerances
    (c) allowances
    (d) types of fits
2. Tools and instruments
    (a) fixed gauges
    (b) adjustable gauges
    (c) precision squares
    (d) gauge blocks
    (e) sine bars
    (f) sine plates
    (g) dial indicators
    (h) comparators
        (i) mechanical
        (ii) electrical
        (iii) optical
        (iv) pneumatic
3. Optical flats
4. Surface finish measurements

Metrology theory should be supplemented by practical experience and/or demonstration where feasible.

a. Describe systems of limits and fits.

b. Identify and describe tools and instruments to use including limit gauges.

c. Describe surface finish measurement and applicable symbols.

d. Select machining processes for given tolerance grades and to produce given finishes.

e. Demonstrate use of gauges and instruments utilized to perform measurement and comparisons.

f. Calibrate measuring instruments and gauges used to perform measurements and comparisons.

SECTION TWO: SHOPWORK

Shopwork experience should relate items outlined in the theory section to shop operations by producing selected shop projects. This experience should complement the theory instruction by providing opportunities for efficient, productive and safe operation and/or demonstration of:

TOPIC

COURSE OBJECTIVES

A. Honing and Lapping

B. Machine Grinding

1. Cylindrical

TOPIC

COURSE OBJECTIVES

2. Surface
3. Internal
4. Tool and cutter

C. Advanced Milling Machine Operations

D. Advanced Engine Lathe Operations

1. Roughing
2. Finishing

E. Machine Broaching

SECTION THREE: TRADE MATHEMATICS

The mathematics content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC

COURSE OBJECTIVES

A. Review of First and Second Year Material

1. Ratio and proportion
2. Manipulation of formulae
3. Advanced table and charts

a. Section A should provide the apprentice with the opportunity to review first and second period mathematics.

B. Introduction to Trigonometry

1. Terminology
    (a) trigonometric functions or ratios
    (b) adjacent and opposite sides
    (c) hypotenuse
    (d) sine, cosine and tangent
2. Trigonometric ratios
    (a) sine
    (b) cosine
    (c) tangent
3. Trigonometric functions
    (a) tables
    (b) calculators
4. Solving for parts of triangles
    (a) right
    (b) equilateral
    (c) isosceles

a. Identify and describe trigonometric and triangle terms including trigonometric ratio.

b. Use tables of natural trigonometric functions to calculate values for angles.

c. Solve for parts of right triangles.

C. Shop Applications of Trigonometry — Imperial and SI

1. Applications
    (a) thread forms
        (i) "V"
        (ii) acme
        (iii) worm
    (b) taper and bevel calculations
    (c) bevel and helical gearing
    (d) sine bar and sine centres
    (e) drill point geometry
    (f) tool clearance angle calculations
    (g) hole locations on bolt circles
    (h) dovetail and V-block calculations
    (i) helix angles
    (j) bolt hole circles and coordinate distances

a. Use trigonometry to solve common machine shop problems.

SECTION FOUR: BLUEPRINT READING

The blueprint reading content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC — COURSE OBJECTIVES

A. Review of First and Second Year Blueprint Reading

1. Dimensioning
2. Sectioning
3. Tolerancing and accumulation of tolerances
4. Fasteners
5. Material specifications
6. Surface finish symbols
7. Welding specifications

a. Section A should provide the apprentice with the opportunity to review first period blueprint reading.

B. Blueprints of Castings — Imperial and SI

1. Design considerations
   - (a) shrinkage allowances
   - (b) machining allowances
   - (c) cooling stresses
   - (d) draft
   - (e) tolerances
   - (f) fillets and radii

a. Identify and describe machining allowances and how they are indicated on castings.

C. Arrowless (Co-ordinate) Dimensioning

1. Arrowless dimensioning applications
   - (a) numerical control
   - (b) jig borer and jig grinder
2. Zero positions
   - (a) centre locations
   - (b) corner locations
   - (c) outside locations
   - (d) other locations within the workpiece
3. Datum and point to point dimensioning
   - (a) applications
   - (b) tolerance considerations
4. True-position dimensioning
   - (a) geometric tolerancing
   - (b) symbols

a. Identify purpose of arrowless dimensioning.

b. Explain applications of zero positioning.

c. Describe datum and true-position dimensioning.

D. Introduction to Machine Shop Estimating

1. Bill of material
2. Job planning
   - (a) correct sequence of machine operations
   - (b) equipment requirements
   - (c) tooling requirements
   - (d) cutting time calculations
   - (e) tolerance and surface finish considerations
3. Cost estimating
   - (a) fixed and variable costs
   - (b) types of estimates

a. Prepare a bill of material.

b. Identify factors affecting job planning and cost estimating.

SECTION FIVE: MACHINERY'S HANDBOOK

Instruction in the use of this book is intended to provide the Machinist apprentice with an opportunity to use the Machinery's Handbook to solve various trade related problems by augmenting theory with the use of tables, formulae, examples and other information.

TOPIC

A. Machinery's Handbook (Suggested Examples) — Imperial and SI

1. Tables of grinding wheels
    - (a) grinding wheels for sharpening milling cutters
    - (b) standard wheel shapes and sizes
    - (c) grinding wheel selection
    - (d) grinding wheel speed tables
    - (e) mounted wheels and shapes
2. Tables of grinding wheel processes
    - (a) cylindrical
        - (i) speeds
        - (ii) feeds
3. Tables of cutter grinding
    - (a) clearance angles
    - (b) tooth rest adjustment
4. Basic process data
    - (a) cylindrical grinding
    - (b) diamond wheels
5. Tables and spur gearing
    - (a) coarse pitch series
    - (b) fine pitch series
    - (c) 20 degrees stub involute
    - (d) 14 1/2 degrees composite
    - (e) long and short addendum
    - (f) nomenclature
6. Tables for gearing
    - (a) centre distance tables
    - (b) backlash ranges and allowances
7. Tables of limits, fits and allowances
    - (a) calculation of shrinkage fit allowances
    - (b) gauge tolerance
    - (c) tables of clearance fits
    - (d) tables of transition fits
8. Metrology tables
    - (a) sine bar constants
    - (b) preferred tolerance tables
    - (c) tables of gauge dimensions
    - (d) surface finish symbols
    - (e) surface finish vs roughness produced
9. Tables of heat treatment (review)
    - (a) SAE alloy steels
    - (b) SAE tool steels
    - (c) high speed steels

COURSE OBJECTIVES

a. Locate and utilize tables, graphs charts and other information pertinent to machine shop requirements.

MACHINIST APPRENTICESHIP TRAINING PROGRAM

FOURTH YEAR	SUGGESTED TIME DISTRIBUTION	SUGGESTED HOURS
SECTION ONE:	THEORY	80 Hours
A. Foundry Work		4 Hours
B. Advanced Milling		12 Hours
C. Press Tool Work		6 Hours
D. Jig Boring and Grinding		4 Hours
E. Machine Tool Maintenance and Electrical Equipment		7 Hours
F. Introduction to Hydraulics		4 Hours
G. Advanced Machining and Special Processes		4 Hours
H. Computer Numerical Machine Tools (C.N.C.)		32 Hours
I. Review of First, Second and Third Year Theory		7 Hours
SECTION TWO:	SHOPWORK	112 Hours
SECTION THREE:	TRADE MATHEMATICS	16 Hours
A. Review First, Second and Third Year Work		4 Hours
B. Advanced Metric Calculations		4 Hours
C. Applications of Math to Shop Problems		8 Hours
SECTION FOUR:	BLUEPRINT READING	24 Hours
A. Review Third Year Work		8 Hours
B. Jigs and Fixtures		16 Hours
SECTION FIVE:	MACHINERY'S HANDBOOK	8 Hours
A. Machinery's Handbook (Suggested Examples)		8 Hours

FOURTH YEAR TECHNICAL TRAINING

SECTION ONE: **THEORY**

TOPIC	COURSE OBJECTIVES
A. Foundry Work — Imperial and SI 1. Terminology 2. Patterns (a) materials (b) manufacturing 3. Sand technology (a) types (b) preparation (c) handling (d) storage 4. Moulding and casting processes (a) sand moulding (b) shell moulding (c) investment mould casting (d) permanent mould casting (e) die casting (f) continuous casting (g) centrifugal casting 5. Foundry tools (a) types (b) use (c) care 6. Safety (a) general (b) regulations	a. Identify and describe the types of patterns and moulds including manufacturing materials, methods and related foundry tools. b. Describe moulding and casting processes. c. Identify and describe safety rules and precautions pertaining to foundry work.
B. Advanced Milling — Imperial and SI 1. Review all methods of indexing 2. Review spur gear theory (a) calculations (b) terminology 3. Helical gearing (a) calculations (b) terminology (c) applications (d) procedures (e) manufacturing methods (f) set-ups 4. Worm gearing (a) uses (b) disadvantages (c) manufacturing methods (d) calculations (e) applications 5. Cams (a) types (b) classes (c) applications (d) set-ups (e) calculations (f) manufacturing methods 6. Splines (a) uses (b) applications (c) manufacturing methods	a. Calculate required indexing. b. Identify and describe spur and helical gear elements including helical gear applications. c. Describe helical gear manufacturing methods, including necessary calculations. d. Describe the types, applications and manufacturing methods for worm gears including necessary calculations. e. Describe cam types, application and manufacturing mehtods. f. Calculate necessary information for cam manufacture. g. Describe spline applications and manufacturing methods. h. Describe linear and circular graduating and methods of manufacturing. i. Identify and describe safety rules and precautions pertaining to milling machines.

TOPIC

COURSE OBJECTIVES

7. Graduating
   - (a) methods
   - (b) linear
   - (c) circular
8. Safety
   - (a) general
   - (b) regulations

C. Press Tool Work — Imperial and SI

1. Presses
   - (a) types
   - (b) functions
   - (c) adjustments
   - (d) set-ups
   - (e) lubrication
   - (f) care
2. Dies
   - (a) simple dies
     - (i) blanking
     - (ii) piercing
   - (b) progressive dies
   - (c) compound dies
   - (d) combination dies
   - (e) bending dies
   - (f) forming dies
   - (g) embossing dies
   - (h) coining dies
   - (i) cutoff dies
   - (j) flexible dies
     - (i) forming process
   - (k) steel rule dies
3. Strip layout considerations in die design
4. Calculations

a. Identify and describe the types, sizing and capacity of punch presses.

b. Identify and describe punch press parts and their maintenance requirements.

c. Identify and describe punch press dies and design considerations of dies.

d. Identify and describe safety rules and precautions pertaining to punch press operations.

D. Jig Boring and Grinding — Imperial and SI

1. Machines
   - (a) types
   - (b) construction
   - (c) function
   - (d) uses
   - (e) accuracy to be expected
2. Methods of hole location
3. Methods of edge location
4. Tools
5. Tool holding devices
6. Work holding devices
7. Accessories
8. Co-ordinating system of locating
9. Types of work performed on these machines
10. Safety
    - (a) general
    - (b) regulations

a. Identify and describe jig borer and jig grinder types, applications, expected accuracy and tooling considerations.

b. Describe methods of location commonly used on jig borers and jig grinders.

c. Identify and describe safety rules and precautions pertaining to jig borers and jig grinders.

E. Machine Tool Maintenance and Electrical Equipment

1. Bearings
   - (a) types
   - (b) advantages of each type

a. Identify and describe the types and machine tool application of bearings and seals including proper installation procedures.

b. Describe types of mechanical drives used on machine tools.

TOPIC	COURSE OBJECTIVES
2. Seals (a) proper use of (b) function of 3. Lubrication (a) bearings (b) gears (c) chains 4. Valves, clutches, brakes and couplings (a) types (b) uses (c) maintenance 5. Belts and pulleys (a) sizes (b) shapes (c) loads (d) replacement procedures 6. Chains and chain drives 7. Electrical (a) grounds (b) overload switches (c) servo motors (d) single phase (e) three phase 8. Cleanliness and safety pertaining to electrical components (a) general (b) regulations	c. Describe applications and purpose of grounds and overload switches on machine tools. d. Describe types of electric motors used on machine tools. e. Identify and describe safety rules and precautions pertaining to machine tool maintenance.

F. Introduction to Hydraulics — Imperial and SI

TOPIC	COURSE OBJECTIVES
1. Basic elements of hydraulic circuits (a) reservoir (b) pump (c) valves (d) motor (i) piston (ii) cylinder (e) conductors (f) fluid 2. Applications of hydraulics (a) hydraulic shapers (b) hydraulic surface grinders (c) hydraulic tracers (d) hydraulic couplings and torque converters 3. Trouble shooting procedures 4. Graphic symbols used in hydraulics 5. Safety (a) general (b) regulations	a. Identify and describe basic components of a hydraulic system. b. Describe applications and trouble shooting procedures for machine tool hydraulic systems. c. Identify and describe safety rules and precautions pertaining to machine tool hydraulic systems.

G. Advanced Machine and Special Processes — Imperial and SI

TOPIC	COURSE OBJECTIVES
1. Advantages, disadvantages and applications of the following: (a) electrical discharge machining (b) electro-chemical machining (c) explosive forming (d) balancing (i) static (ii) dynamic	a. Describe applications, techniques and safety considerations of advanced and special machining processes. b. Describe safety rules and precautions pertaining to advanced machine and special processes.

TOPIC

2. Any other new development in machine tool technology
3. Safety
    (a) general
    (b) regulations

H. Computer Numerical Control Machine Tools (C.N.C.)

1. Brief history of N.C. and C.N.C. including advantages and disadvantages.
2. Comparison of N.C. to C.N.C., D.N.C.
3. Computer assisted manufacturing (C.A.M.)
    (a) applications
    (b) advantages, disadvantages
4. Economics of C.N.C.
    (a) areas of comparability
    (b) C.N.C. versus conventional machining
    (c) factors to be considered in evaluation
        (i) break-even point
        (ii) determination of break-even point
        (iii) economic advantages of small batches
        (iv) labor costs
5. Types of C.N.C. machine tools
    (a) drilling machines
        (i) simple
        (ii) general
        (iii) complex
    (b) lathes
    (c) bar and chucking machines
    (d) milling machines
    (e) machining centres
    (f) boring mills
        (i) vertical
        (ii) horizontal
    (g) electro-discharge machining (E.D.M.)
    (h) punches, presses
    (i) new trends in machine tool technology
6. Types of control
    (a) point to point
    (b) contouring or continuous path
7. Tooling systems and tool changers
    (a) pre-set tooling
    (b) auto tool changers
        (i) turret
        (ii) drum
        (iii) chain
8. C.N.C. programming
    (a) review feeds speeds
    (b) codes
        (i) G codes
        (ii) F codes
        (iii) M codes
        (iv) T codes
        (v) I, J, K codes

COURSE OBJECTIVES

a. Describe C.N.C. operations, advantage and disadvantages.
b. Identify and describe types of C.N.C. machine tools and controls.
c. Describe tooling systems available.
d. Describe tool changers.
e. Perform basic programming and tape preparations.
f. Identify and describe safety rules and precautions pertaining to C.N.C. machine tools operations.

TOPIC COURSE OBJECTIVES

    - (vi) definition of canned cycle
  - (c) absolute/incremental data input
  - (d) description and features of C.N.C. controls
    - (i) set-up of "x" and "y" locations in relation workpiece and table axis
  - (e) set-up of "z" axis using
    - (i) quill
    - (ii) MDI input
    - (iii) tape input
  - (f) defining tape block format
    - (i) word address
    - (ii) compact II
    - (iii) symbolic
  - (g) set point explanation and application
  - (h) writing a simple program
  - (i) loading and running program using MDI
  - (j) tapes
    - (i) types
    - (ii) language
    - (iii) how to load practice
  - (k) mirror image
    - (i) definition
    - (ii) where, why, how to use
  - (l) math and formulas used to calculate
    - (i) tool length compensation
    - (ii) tool radius compensation
    - (iii) cutter offsets
    - (iv) home to start point computations

9. Safety
   - (a) general
   - (b) regulations

I. Review of First, Second and Third Year Theory

The review section should provide the apprentice with the opportunity to briefly review and refresh his/her knowledge of the theory contained in the first, second and third year.

SECTION TWO: SHOPWORK

Shopwork experience should relate items outlined in the theory section to shop operations by producing selected shop projects. This experience should complement the theory instruction by providing opportunities for efficient, productive and safe operation and/or demonstration of:

TOPIC COURSE OBJECTIVES

A. Foundry Practices

B. Advanced Milling Machine Operations

1. conventional
2. C.N.C.

C. Boring Mill

D. Advanced Engine Lathe Operations

1. conventional
2. C.N.C.

E. Machine Grinding

SECTION THREE: TRADE MATHEMATICS

The mathematics content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC	COURSE OBJECTIVES
A. Review Work — Imperial and SI	
1. Metric system (SI) (a) kilometre (b) metre (c) centimetre (d) millimetre (e) decimal fractions of the millimetre 2. Metric and inch dimensional relationship 3. Axioms for solving equations and formulae 4. Setting-up ratios and proportions 5. How to apply Pythagorean theorem to triangles 6. Ratio and proportion and standard triangles for solving triangles 7. Trigonometric ratios and functions (a) sine (b) cosine (c) tangent 8. How to use trigonometric tables 9. How to read (a) graphs (b) tables (c) charts 10. Construction of (a) graphs (b) tables (c) charts	a. Section A should provide the apprentice with the opportunity to review the first, second and third periods mathematics.
B. Advanced Metric Calculations	
1. Calculations in the metric system involving (a) cutting speeds (b) threads (c) tapers (d) feeds (e) speeds (f) module gears (g) module worms 2. Any other problems arising in the machine shop due to metric conversion	a. Calculate trade problems involving the metric system.
C. Applications of Math to Shop Problems — Imperial and SI	
1. Calculations related to (a) gearing (b) metrology (c) foundry work 2. Mechanics and strength of materials as related to press work	a. Calculate trade problems related to gearing, press work and other shop problems as they arise.

TOPIC	COURSE OBJECTIVES
3. Other advanced problems as may arise	

SECTION FOUR: BLUEPRINT READING

The blueprint reading content in this course outline should maintain relevancy to technical training and be directly related to practical job applications.

TOPIC	COURSE OBJECTIVES
A. Review work	
1. Review the third year Blueprint Reading unit dealing with arrowless (co-ordinate dimensions)	a. Section A should provide the apprentice with the opportunity to review the third period blueprint reading dealing with arrowless dimensioning.
B. Jigs and Fixtures — Imperial and SI	
1. Principles of design (a) location (i) redundancy (ii) foolproofing (b) clamping (c) clearance (d) rigidity (e) handling (f) economy (g) general (h) safety	a. Identify and describe types of jigs and fixtures. b. Describe design considerations for jigs and fixtures including locating and clamping devices. c. Design and sketch simple jigs and fixtures.
2. Locating and clamping devices (a) pads (b) pins (c) V-blocks (d) sighting plates (e) clamps (f) bushings (g) washers (h) nuts (i) cams	
3. Types of jigs and fixtures (a) jigs (i) plate (ii) solid type (iii) turn over (iv) local (v) box (b) fixtures (i) single (ii) multiple (iii) plain (iv) string (v) assembly (vi) welding (vii) turning (viii) boring (ix) gang (x) indexing (xi) rotary (xii) grinding (xiii) broaching	
4. Clamping methods (a) mechanical (b) pneumatic (c) hydraulic (d) electric-magnetic	

TOPIC COURSE OBJECTIVES

5. Sketching of jigs and fixtures
   - (a) evolution of the sketch
   - (b) detailing

SECTION FIVE: MACHINERY'S HANDBOOK

Instruction in the use of this book is intended to provide the Machinist apprentice with an opportunity to use the Machinery's Handbook to solve various trade related problems by augmenting theory with the use of tables, formulae, examples and other information.

TOPIC COURSE OBJECTIVES

A. Machinery's Handbook (Suggested Examples) — Imperial and SI

1. Tables of bearings
   - (a) material for plain bearings
   - (b) babbitt composition
   - (c) types and characteristics of antifriction bearings
     - (i) fillet radius
   - (d) limits and tolerances of antifriction bearings
2. Tables of pipes and pipe fittings
   - (a) dimensions and schedules
   - (b) definitions of pipe fittings
   - (c) sizes of tubing
     - (i) seamless
     - (ii) welded
3. Tables of worm gearing
   - (a) formulae
   - (b) tooth proportions
4. Tables of gear material
   - (a) case hardening steels
   - (b) thorough hardening steels
   - (c) bronzes
   - (d) nonmetallic
5. Tables for broaching
   - (a) design data
   - (b) broaching pressures
6. Tables for belt, pulleys and sprockets
   - (a) dimensions and tolerances
7. Tables for splines and clutches
   - (a) symbols
   - (b) dimensions and tolerances
8. Tables fo helical gearing
   - (a) arrangements
   - (b) cutter selection
   - (c) nomenclature
   - (d) change gears for milling helical gears
9. Tables and charts for cam milling
   - (a) change gears
   - (b) angles
10. Gear data tables — Imperial and SI
    - (a) application and quality numbers
    - (b) formulae for milled bevel gears
    - (c) over wire measurement spur gears

TOPIC	COURSE OBJECTIVES
11. Tables of foundry practices (a) melting temperatures (b) properties of castings	

SUGGESTED BOOKS OF REFERENCE

Technology of Machine Tools — Drar, Oswald and St. Amand (McGraw Hill Publishing Co.)

Machinery's Handbook — Latest Edition — Oberg, Jones and Horton (Industrial Press)

Interpreting Engineering Drawings — Jensen and Hines (Delmar Publishers)

Mathematics For Machinists and Millwrights — W. Hoffman (N.A.I.T. Published) N.A.I.T. and Keyano College

TECHNICAL TRAINING SCHOOLS

The Machinist apprenticeship training program is offered by the Alberta Manpower, Apprenticeship and Trade Certification Division. Staff and facilities for teaching the program are supplied by:

1. Northern Alberta Institute of Technology
2. Southern Alberta Institute of Technology
3. Keyano College (First Period Only)

LOCATION OF APPRENTICESHIP AND TRADE CERTIFICATION DIVISION REGIONAL OFFICES

BONNYVILLE

CALGARY

EDMONTON

FORT McMURRAY

GRANDE PRAIRIE

HINTON

LETHBRIDGE

MEDICINE HAT

PEACE RIVER

RED DEER

VERMILION

GOVERNMENT OF THE PROVINCE OF ALBERTA

ALBERTA REGULATION 326/81

(Filed on September 2, 1981)

THE MANPOWER DEVELOPMENT ACT

MINISTERIAL ORDER

I, James D. Horsman, Minister of Advanced Education and Manpower, pursuant to sections 30(2) and 37(2) of The Manpower Development Act, make the Regulation in the attached Appendix being the Machinist Trade Regulation.

Dated at Edmonton, Alberta, August 27, 1981.

JAMES D. HORSMAN,
Minister of Advanced Education
and Manpower

APPENDIX

THE MANPOWER DEVELOPMENT ACT

Machinist Trade Regulation

1(1) In this regulation

(a) ''machinist'' means a person who sets up or operates metal removing machine tools to manufacture metals and other materials into precise shapes and sizes according to specifications;

(b) ''General Regulations'' means the General Regulations under The Manpower Development Act, (Alta. Reg. 43/77);

(c) ''trade'' means the trade of machinist.

(2) The definitions in the General Regulations apply in this regulation.

PART 1

APPRENTICESHIP AND TRADE TRAINING

2 A person is eligible to be an apprentice machinist if he satisfies the requirements of section 5 of the General Regulations, and either

(a) produces evidence of at least a grade 9 education, or

(b) passes the entrance examination prescribed by the Board.

3(1) Subject to subsections (2), (3) and (4), an employer who is a journeyman, or who employs a journeyman, may employ one apprentice and may employ one additional apprentice for each additional journeyman he employs.

(2) If the supply of journeymen in a location where an employer is carrying on business is insufficient to permit the employer to carry out his work commitments, the Director may authorize the employer to employ apprentices in addition to those permitted under subsection (1).

(3) The Director may authorize an employer to employ an apprentice in addition to those permitted under subsections (1) and (2) on a temporary basis, to train him in a branch of the trade not engaged in by the employer to whom he is apprenticed.

(4) For the purposes of subsections (1) and (2) an apprentice employed temporarily under subsection (3) shall not be considered to be an apprentice of his temporary employer.

4(1) The term of apprenticeship shall be 4 periods of 12 months each.

(2) Each period referred to in subsection (1) shall consist of not less than 1800 hours of employment, inclusive of time spent attending technical courses prescribed by the Board.

(3) The Director may not under section 25(1) of the Act, reduce the term of apprenticeship to be served by an apprentice to less than one period of apprenticeship.

5 When a contract of apprenticeship is registered with the Director, he shall issue to the apprentice an official record book referred to in section 14 of the General Regulations.

6(1) An apprentice shall not advance to the next period until the Director has authorized him to do so by making an entry in the apprentice's official record book under subsection (2).

(2) The Director shall make an entry in the apprentice's official record book authorizing advancement to the next period, when the apprentice

(a) has completed the previous period of apprenticeship,

(b) has received in the opinion of the Director, a satisfactory report from

(i) his employer, and

(ii) the school at which he attended technical courses prescribed by the Board,

(c) has completed the tests and examinations prescribed by the Board, and

(d) has attained passmarks prescribed by the Board in those tests and examinations referred to in clause (c).

7 The official record book of an apprentice shall be kept in the possession of his employer, and on the termination of the employment of the apprentice, the employer shall present the completed book to him.

8(1) An employer shall pay wages to an apprentice that are not less than the following percentages of the prevailing wages paid to a journeyman:

(a) 55% in the first period;

(b) 65% in the 2nd period;

(c) 75% in the 3rd period;

(d) 85% in the 4th period.

(2) Notwithstanding subsection (1), the wages paid to an apprentice shall not be less than the minimum wage fixed pursuant to The Employment Standards Act.

(3) An employer is not required to pay wages to an apprentice during the time that the apprentice spends attending technical training courses prescribed by the Board.

9 The hours of work and working conditions of an apprentice shall be the same as those of a journeyman.

PART 2

CERTIFICATION

10 The Director may issue the following class of certificates in the trade:

(a) Certificate of Qualification.

11 In accordance with section 32(d) of the General Regulations, the Director may issue a Certificate of Qualification for the trade, without examination, to a person who holds

(a) a Certificate of Completion of Apprenticeship issued by another province within Canada, or

(b) a Certificate of Qualification or a Certificate of Proficiency issued by another province within Canada, bearing an Interprovincial Standards Red Seal.

12(1) An application to take an examination for a Certificate of Qualification shall be made to the Director.

(2) Documentary evidence acceptable to the Director shall be presented by an applicant for an examination showing that the applicant

(a) holds a certificate equivalent to an Alberta Certificate of Qualification issued by a provincial authority outside Alberta, or

(b) has at least 4 years of acceptable work experience in the trade.

(3) The applicant shall provide translations into the English language, acceptable to the Director, of credentials other than in English, submitted pursuant to subsection (2).

13 A Certificate of Qualification issued under this regulation is effective unless cancelled or suspended by the Director in accordance with section 42 or 43 of the General Regulations.

14 Alberta Regulation 81/76 is repealed.

N.L.C. - B.N.C.
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